



DATA ANALYSIS FOR CLOUD COVER AND RAINFALL OVER BAGHDAD CITY, IRAQ

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Abstract

Clouds are condensed droplets or ice crystals from atmospheric water vapor. Clouds form by the rising and cooling of air caused by convection, topography, convergence and frontal lifting. Clouds are basically divided into two classes, based on appearance: there are single layer (Stratiform) clouds and accumulated (Cumuliform) clouds, which can both occur at different altitudes throughout the troposphere. Data are taken by cloud cover types and rainfall from satellites recorded by the European Centre for Medium-Range Weather Forecasts (ECMWF). The choice of 2018 year over Baghdad city between the two latitudes (33.375° - 44.375°) north and longitudes (33.375° - 44.375°) east. Otherwise, we have studied daily mean of LCC, MCC, HCC and rainfall, the monthly mean of LCC, MCC, HCC and rainfall, as well as the relationship between LCC, MCC, HCC and rainfall. The results showed that the relationship between LCC and rainfall is positive, the relationship between MCC and rainfall is positive but the relationship between HCC and rainfall is inverse and represents lowest correlation while LCC and rainfall represents highest correlation. As well as the highest amount of rainfall occurred on 28/2 - 28/4/2018 due to the presence of Cb and Ns clouds.

Key words: Cloud cover, Rainfall, ECMWF, Baghdad, Iraq.

Introduction

In meteorology, a cloud is an aerosol consisting of a visible mass of minute liquid droplets, frozen crystals, or other particles suspended in the atmosphere of a planetary body or similar space. Water or various other chemicals may compose the droplets and crystals. On Earth, clouds are formed as a result of saturation of the air when it is cooled to its dew point, or when it gains sufficient moisture (usually in the form of water vapor) from an adjacent source to raise the dew point to the ambient temperature (Warren *et al.*, 2007).

Levels of Clouds and Rains

Tropospheric clouds form in any of three levels based on altitude range above the Earth's surface. The base-height range for each level varies depending on the latitudinal geographical zone. Each altitude level comprises two or three genus-types differentiated mainly by physical form (Hartmann *et al.*, 1992):

1. High-Level: High clouds form at altitudes of 3,000 to 7,600 m in the Polar Regions, 5,000 to 12,200 m in the temperate regions and 6,100 to 18,300 m in the tropics.

As included cirrus (Ci), cirrocumulus (Cc) and cirrostratus (Cs). Where this cloud type (Ci, Cs) not produce precipitation, (Cc) is composed of ice crystals or super cooled water droplets and produces precipitation that evaporates below the base of the cloud (Wu, 1987).

2. Mid-Level: These clouds can form as low as 2,000 m above surface at any latitude, but may be based as high as 4,000 m near the poles, 7,000 m at mid-latitudes and 7,600 m in the tropics and composed of a mix of water droplets and ice crystals. As included Altostratus (As), Altostratus (As) and Nimbostratus (Ns). Where this cloud types (Ac and As) can produce very light precipitation that evaporates before reaching the ground and Ns cause continuous rain and snow (Warren *et al.*, 1985).

3. Low-Level: Low clouds are found from near the surface up to 2,000 m. Clouds that form in the low level of the troposphere are generally of larger structure than those that form in the middle and high levels. As included Stratus (St), Stratocumulus (Sc) and Cumulus (Cu) and Cumulonimbus (Cb). Where, this cloud types (St, Sc, Cu) can produce moderate to heavy showers. While (Cb) is

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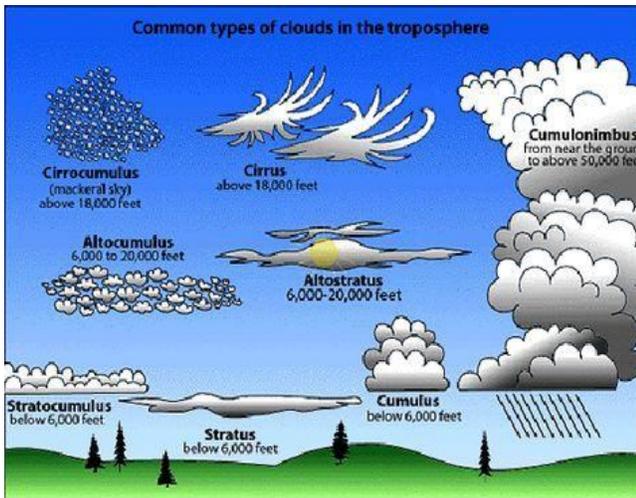


Fig. 1: The cloud cover types within the troposphere layer.

a heavy, towering, cumulonimbi form mass of free convective cloud with a dark-grey to nearly black base and a very high top in the form of a mountain or huge tower. Cumulonimbus can produce thunderstorms, local very heavy downpours of rain that may cause flash floods, lightning and heavy snow showers, hail, strong wind shear and tornadoes (Wood and Bretherton, 2006). As shown in the fig. 1.

Literature Review

There many from studies to find effect of cloud cover as Studied the characteristics of low, medium and high clouds affecting Iraq and the number of 27 types in terms of coverage and bases height may concluded that the difference in seasons affects coverage ratio if increasing converge ratio in winter and less in spring and autumn (AL-dzini, 2005). Studied the classification of clouds based on atmospheric stability over Baghdad city showed that it was found that the high clouds are stable base and stable under the base, medium and low clouds stable base stable and unstable under the base (Muhammad, 2017). The calculation of absorption and emission of thermal radiation by clouds cover and resulted the relationship between absorption and emission is positive as increasing absorption leads to increased emission (Abbood and Al-Taai, 2018a). Some research showed that the absorbance and emissivity solar radiation by clouds, aerosols and some atmospheric gases and concluded that absorption, emissivity and albedo by clouds, aerosols and gases depends on the quantity, type, abundance, composition, location, atmospheric lifetime, season, meteorological parameter (temperature, pressure, wind, relative humidity and rains), wavelength of each air component, incident angle through the strength of the solar and thermal radiation where these factors which play very important role in term of cooling and heating magnitudes (surface

and atmosphere) at the times (00:00 am, 12:00 pm) (Abbood and Al-Taai, 2018b).

Materials and Methods

The Data and Study Area

Data were taken from the European Center for Medium-range Weather Forecasts (ECMWF) for daily and monthly means of cloud cover types (low, medium and high) and daily and monthly means of rainfall for the 2018 year over Baghdad city within the two latitudes (33.375°-44.375°) where featuring extremely hot, dry summers and mild winters (Al-Riahi *et al.*, 2003). As shown in fig. 2.

Statistical Used

Choosing Spearman Rho (SRT) from several statistical tests has been selected regression analysis. Using statistical program Sigma plot to figure out the slope of the regression (b) and p-value simple linear regression way to detect the relationship between cloud cover types and rainfall by simple linear regression (SLR) as following equation (Levesque, 2007):

$$\bar{Y} = a + b \bar{X} \quad (1)$$

\bar{X} = Independent variable, \bar{Y} = Dependent variable. a= Constant gradient, b=Slope of the regression (Dahiru, 2008). The Spearman rank correlation coefficient (r_s) is given to the following equation (Sedgwick, 2014):

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)} \quad (2)$$

d_i = The ranked difference between the i th measurements for the two varieties. n = Sample size (Myers and Sirois, 2004).



Fig. 2: Baghdad city in Iraq.

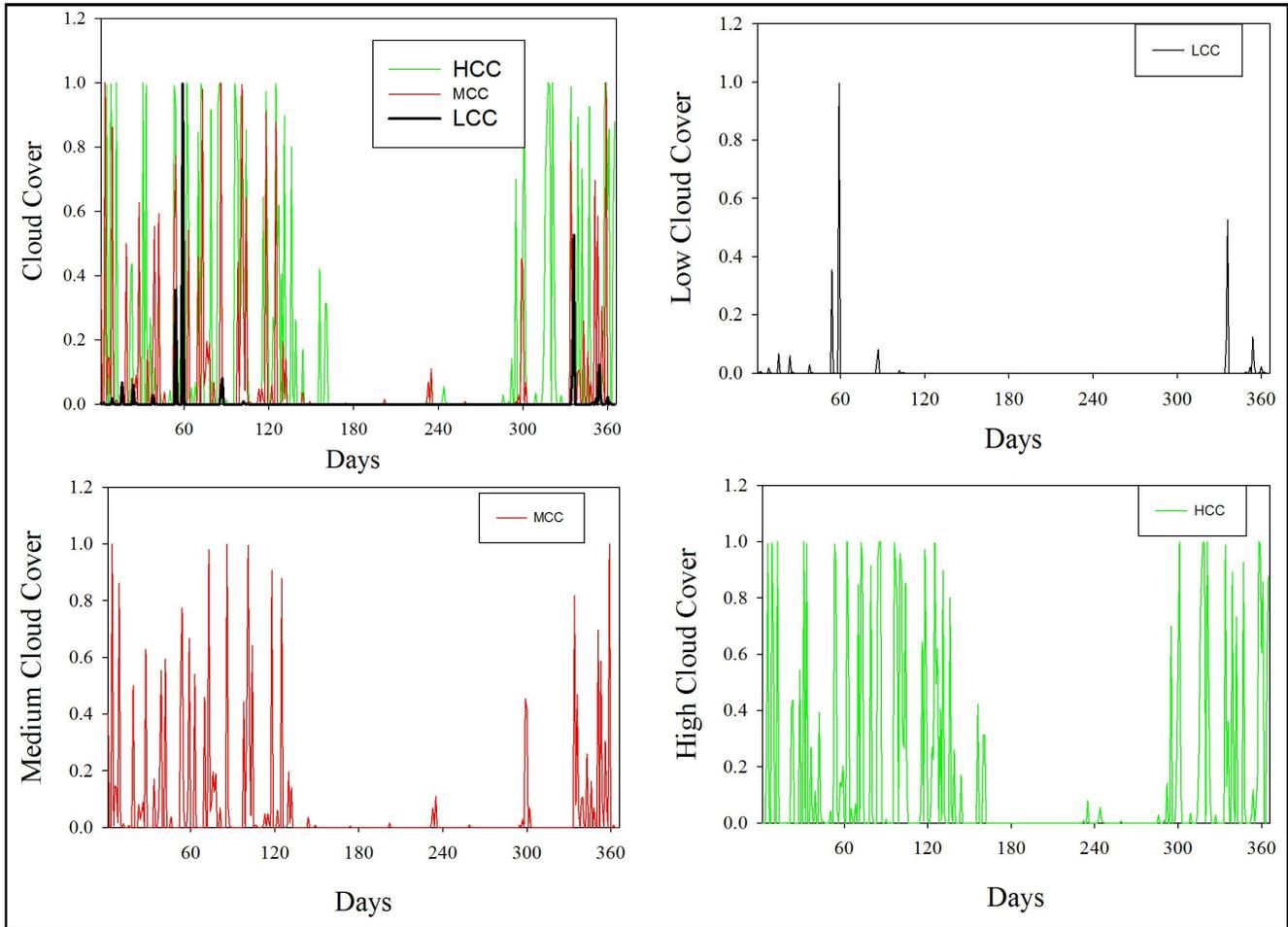


Fig. 3: The daily mean of cloud cover types (LCC, MCC and HCC) data for the year 2018 over Baghdad city.

Results and Discussions

The Daily Mean of Cloud Cover (LCC, MCC and HCC) over Baghdad City

The fig. 3 shows the largest number of low clouds occurred on 28/2, 2/12 where four types of clouds are St, Sc, Cu and Cb where the weather is unstable and produce

moderate to heavy showers. While the largest number of medium clouds occurred on 4/1, 14/3 27/3, 11/4, 28/4, 25/12 where three types of clouds are As, Ac and Ns where the weather is unstable and produce precipitation. While the largest number of high clouds occurred on 12/1, 31/1, 3/3, 27/3, 28/10, 24/12 where three types of high clouds are Ci, Cc and Cs where the weather is stable and not produce precipitation.

The Daily Mean of Rainfall over Baghdad City

Table 1: The relationship between cloud cover (low, medium and high) with the rainfall for 2018 over Baghdad city.

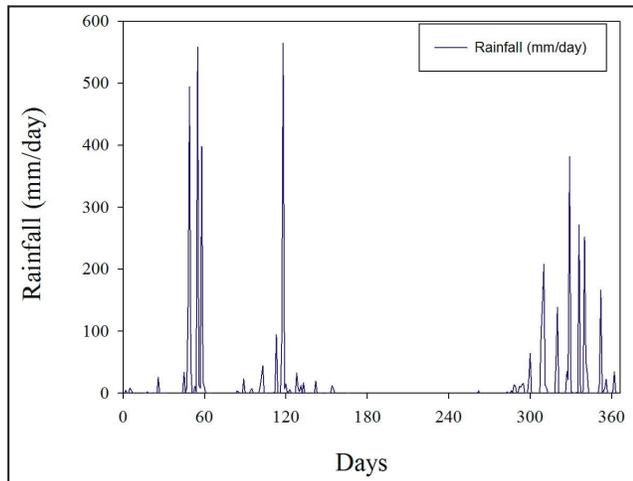


Fig. 4: The daily mean of rainfall data for the year 2018 over Baghdad city.

Hour		Spearman rho	Linear regression Simple	
Daily mean	R	Correlation degree	P-value	Interpretation
LCC vs Rainfall	0.187	Low positive correlation	0.095	Linear relation
MCC vs Rainfall	0.182	Low positive correlation	<0.001	Linear relation
HCC vs Rainfall	-0.175	Low inverse correlation	<0.001	Linear relation

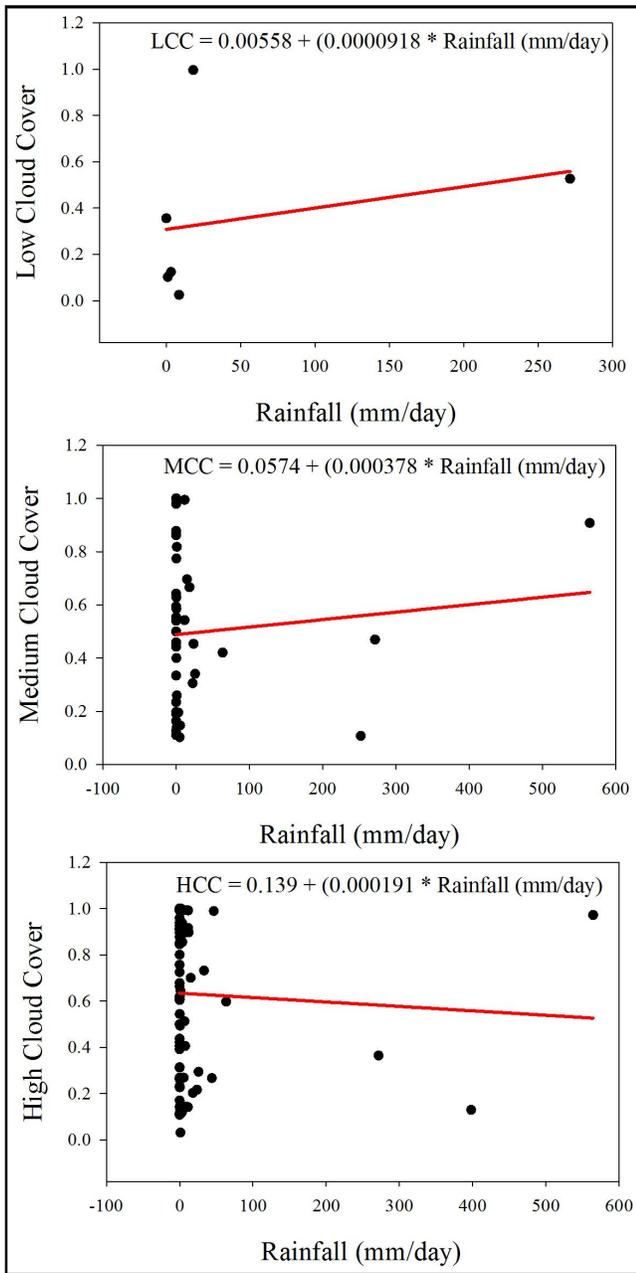


Fig. 5: The relationship between the cloud cover types and rainfall for the year 2018 over Baghdad city.

The fig. 4 shows the highest quantity of rainfall occurred on 18/2, 24/2, 28/2, 28/4 where two types of low and medium clouds that causes weather is unstable and produce moderate to heavy showers.

The Relation between the Daily Mean of Cloud Cover and Rainfall over Baghdad City

The fig. 5 and the table 1 shows the type of relationship and the strength of the correlation between cloud cover types and rainfall for selected Baghdad city. Where the relationship between LCC and the rainfall is positive low correlation represents (0.187) and the relationship between MCC and rainfall is positive low correlation

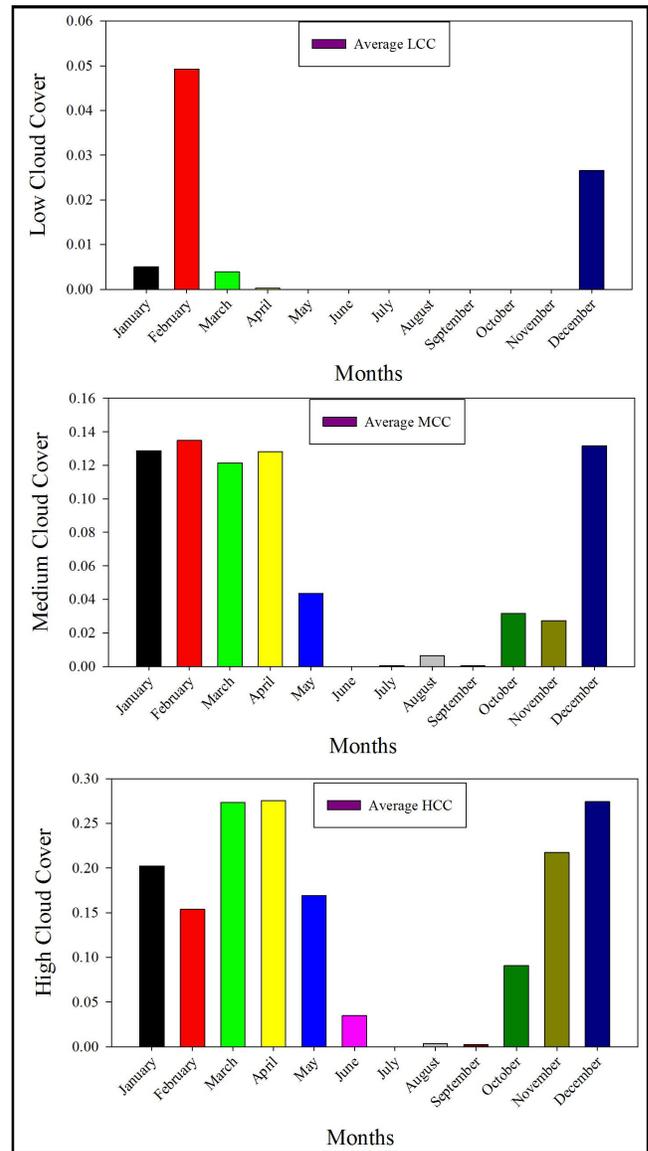


Fig. 6: The monthly mean of cloud cover types (LCC, MCC and HCC) data for the year 2018 over Baghdad city.

represents (0.182) but the relationship between HCC and the rainfall is inverse low correlation represents (-0.175). This is due to the main cause of rain are low and medium clouds but high clouds are not accompanied by rain.

The Monthly Mean of Cloud Cover (LCC, MCC and HCC) over Baghdad City

The fig. 6 shows The cloud increase (LCC, MCC and HCC) in winter and spring and decreases in autumn and summer because of the low temperature that acts on the formation of clouds and rain as well as meteorological parameters others and nuclei to condense.

The Monthly Mean of Rainfall over Baghdad City

The fig. 7 shows The rainfall increase in winter and spring and decreases in autumn and summer because of the low temperature that acts on the formation of clouds

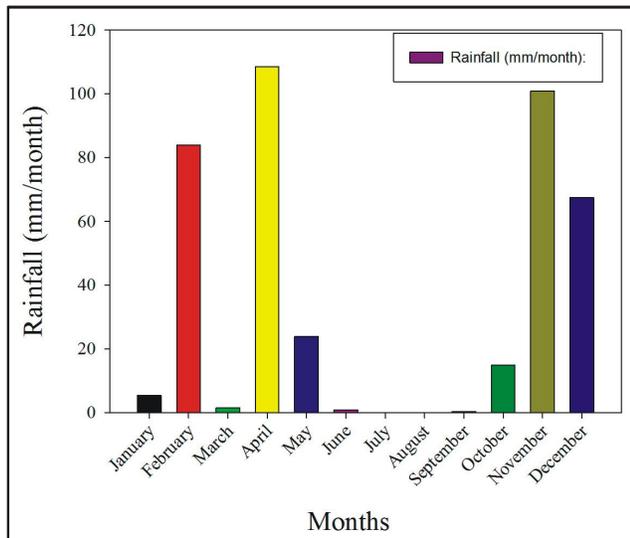


Fig. 7: The daily mean of rainfall data for the year 2018 over Baghdad city.

and rain as well as meteorological parameters others and nuclei to condense.

Conclusions

- The increase low, medium and high clouds in winter and spring but decrease in autumn and spring.

- The relationship between low and medium clouds is positive as but the relationship between high clouds is inverse. This is due to the main cause of rain are low and medium clouds but high clouds are not accompanied by rain.

- The increase rainfall in winter and spring and decrease in summer and autumn this is due to the thickness, location, water vapor concentration and meteorological parameters for clouds.

- The highest amount of rainfall occurred on 28/2/2018-28/4/2018 due to the presence of low cloud as cumulonimbus and medium cloud as nimbostratus therefore the occurrence of thunderstorms and the occurrence of precipitation in the form of showers and may be accompanied by hail sometimes.

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